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ABSTRACT

The application of multiple linear regression to the problem of identifying appropriate criterion variables and predicting enrollment in college courses during a period of major rapid decline was studied. Data were gathered on course enrollments for 1972-78 at Kent State University, and five independent variables were selected to determine the most likely indicators of future enrollment trends. The variables were: total departmental majors in elementary education, elementary education majors plus all those enrolled in service courses and allied majors, the number of elementary education freshmen enrolled for each year, total enrollment of the college of education by year, and total university enrollment. Data were analyzed using Multiple Regression Analysis: Subprogram--Regression from the "Statistical Package for the Social Sciences" (SPSS; Nie, Hull, Jenkins, Steinbrennar, and Bent, 1975). Total college enrollment proved to be the best single predictor. The technique proved to be 96 to 100 percent accurate in estimating course enrollments in seven of the 10 courses. It is also a valuable means for data-based decision-making and long-range planning when faculty committees must advise on administrative decisions. (Author/SW)

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MULTIPLE LINEAR REGRESSION AS A TECHNIQUE FOR PREDICTING COLLEGE ENROLLMENT

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Abstract

This paper deals with the application of multiple linear regression to the problem of identifying appropriate criterion variables and predicting enrollment in college courses during a period of major rapid decline. Data was gathered on course enrollments for 1972 - 1978 and organized around five criterion variables. Total college enrollment proved to be the best single predictor with correlations of .89 to .99 with each of ten departmental course enrollments. The technique has proved to be 96 to 100 per cent accurate in estimating course enrollments in seven of the ten courses. It is also a valuable means for data-based decision making and long range planning when faculty committees must advise on administrative decisions.

MULTIPLE LINEAR REGRESSION AS A TECHNIQUE FOR PREDICTING COLLEGE ENROLLMENT[1]

A problem faced by most administrators is scheduling staff to meet teaching requirements. In periods of changing enrollments in colleges and universities, it becomes important for adminstrators to have available a reliable means for predicting enrollment patterns in courses and departmental programs. Such a tool can be used to allocate resources more efficiently (staff and building use), as well as to provide a sound, empirical base for informed decision making--particularly when management decisions are shared with other groups.

This paper deals with the application of multiple linear regression to the problem of identifying appropriate criterion variables and predicting enrollment in college courses. While the initial focus was to develop enrollment patterns and predictions for a single department, the model can be used as a comprehensive tool for colleges or universities.

Background

In 1972 more than 1,862 students graduated from the College of Education at Kent State University. Of these, 566 were majors in the Department of Elementary Education (ELED). At that time Kent State ranked third in the nation in the number of elementary school teachers graduated. Two factors dramatically reversed this situation. The first was the tragic events of the shooting of four students on the campus on May 4, 1970 which produced a sudden, rapid decline in university enrollments. The second major factor was the growing surplus

[1]*The authors wish to thank Sonya Blixt and Madeleine Mathis of Kent State University for their help with the statistical analyses.*

of teachers in the 1970's. Since 1972 there has been a continual, rapid decline in the number of students enrolled in the college and in elementary education. This decline of about 23 percent per year was evident in the number of new freshmen majors enrolled in ELED, but it was not so readily apparent in ELED class enrollments for two reasons: 1) the impact of loss in freshmen majors was delayed for two years because ELED courses are taught at the junior-senior level; and 2) there was significant increases in the majors in special education and early childhood education from 1971 to 1975 in response to national and regional needs. Many of these students took ELED courses as dual majors or as service courses for their own major.

In the past years, class scheduling and faculty assignments were made on a short-term basis, usually only one or two quarters in advance. Reasonable estimates could be made using an inventory which provided historical data on class enrollments and on the number of sections offered during the previous six quarters. Estimates could be adjusted on the basis of pre-enrollment figures which were available about six weeks before the start of a new quarter.

In the fall of 1976 freshmen majors in ELED dropped to an all time low of 81. Enrollments in special education and early childhood education also dropped noticeably. The University's tight financial position and major budget cuts in the College of Education made it evident that no additional faculty appointments could be expected even to replace losses due to retirement or resignation. The purpose of this study, therefore, was to identify those criterion variables that could be

used to predict department enrollments in order to provide more orderly planning for scheduling of classes and in the management of faculty assignments.

Source of Data

The data for the study was derived from several official university records for the years 1972 through 1978. These included enrollments by course; the number of students enrolled as majors in elementary education and other departmental areas; total college enrollment; and total university enrollment.

Five independent variables were selected to determine the most likely indicators of future enrollment trends. These were: 1) total departmental majors in elementary education for the years 1972-1978; 2) elementary education majors plus all those enrolled in service courses and allied majors; 3) the number of elementary education freshmen enrolled for each year; 4) total enrollment of the College of Education by year for the period 1972-1978; and 5) total university enrollment.

Data Analysis

Data were analyzed using Multiple Regression Analysis: Subprogram — Regression from the Statistical Package for the Social Sciences (SPSS; Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). Enrollment totals by year for ten ELED courses were the dependent variables with the five variables listed above as the independent variables. Criterion for inclusion of successive variables in the stepwise regression was $p < .05$.

Results

Results of the multiple regression analysis indicated that the best single predictor was total college enrollment. When other variables were entered in the stepwise regression, their contribution was nonsignificant. As Table 1 indicates correlations between individual courses and total college enrollments were exceptionally high ranging from .89 through .99.

Insert Table 1 about here.

Examination of the correlation matrix shown in Table 2 indicated that

Insert Table 2 about here.

two other variables (ELED majors, and ELED majors plus those enrolled in service courses and allied majors) correlated highly (.79 to .91) with total college enrollment. On the other hand, total university enrollment had only a moderately low correlation (.23 to .35) with college enrollment, suggesting that factors related to college enrollment were probably quite different from those related to total university enrollment. The strong inverse relationships between freshmen in elementary education and total college enrollment probably is accounted for by the fact that all ten courses are offered at junior-senior level and thus no freshmen are included in the enrollment data.

Figure 1 shows the correlations between course enrollment and total

Insert Figure 1 about here.

college enrollment, and the equations used to predict enrollment.

Predicting Course Enrollments, 1978-1980

Several steps were involved in determining enrollment estimates for 1978-79 and 1979-80. The first step was to develop an accurate estimate of total college enrollments for the two-year period. This was done by averaging the annual decrease over the years 1974 through 1977. The average decrease was 297. Since it appeared likely that the total college enrollment will continue to drop, a decrease of 297 was estimated for both years 1978 and 1979. While the declines in elementary education and in other areas are more rapid and

would indicate a greater decrease, those losses are offset by increases in vocational education where older students are enrolling to seek certification in trades and industries and related programs.

Once total college enrollments were estimated, individual course enrollments were estimated using the general regression equations indicated in Figure 1. In order to allocate the total number of students predicted for the year in any one class to each of the four quarters, a format similar to that shown in Figure 2 was devised. This allocation over quarters was based on an

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Insert Figure 2 about here.

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analysis of the preceding five-year enrollment pattern for that particular course for each quarter. As shown in Figure 2 the percentage that each quarter represents of the total year's enrollment is then determined. Using ELED 31122 as an example, Fall quarter 1978 represents 38 percent of the estimated enrollment for that class or 25 students of the predicted total of 66. A similar determination was made for the remaining quarters. Enrollment figures for each quarter were based on similar estimates for each of the departmental courses.

How accurate were these predictions? An analysis of actual enrollment data during Fall quarter 1978 indicated that in seven out of ten of the courses the estimates ranged between 96 and 100 percent accurate. In three courses the margin of error was ten per cent or 90 per cent accuracy. In practical terms this meant that in one course 96 students were predicted and 100 enrolled; in another 93 students were predicted and 96 enrolled. In a third case, 43 were predicted and 43 enrolled. In each case actual enrollments were slightly higher than the predicted figure.

Discussion

A number of important implications appear to stem from this study. The

accuracy of prediction described above leads to more precise advanced planning of faculty resources. Faculty teaching loads can be worked out for an entire academic year. Where necessary, faculty can be shifted to other responsibilities if enrollment estimates are low. If additional sections of a course are warranted, temporary faculty can be hired well in advance rather than waiting for final registration figures. Rooms and other university resources can also be more efficiently allocated based upon highly accurate predictions. This technique has also proved useful in long-range planning in that enrollment trends can be used to validate decisions whether or not to retain faculty positions when they become vacant through retirement or resignation, or to reallocate faculty and budgetary resources to other areas where student enrollment needs are greater.

Another important implication is that use of the technique described here provides an empirical basis for informed decision making when such decisions must be shared with other constituent groups. It also reduces the influence of subjectivity and personality in decision making. For example, during a time of considerable tension and anxiety among faculty about declining enrollment and possible retrenchment, this technique proved an excellent source of data for making difficult decisions about the number of classes to be scheduled, faculty loads, and reassignment to other duties. Data from a preliminary version of this study was used to validate the need for a reduced summer school program and a more limited employment of faculty for summer school teaching. When administrative proposals were accompanied by the data on enrollment predictions as described above, the department executive committee recommended the acceptance of the reduced program and turned its attention to the consideration of other alternatives.

Several other uses might be considered for further application of this model. Whereas this study dealt with the enrollment in a single department,

the model could be extended to a number of departments in a college or to an all-university model. Obviously, other relevant variables would need to be examined and selected carefully depending on the circumstances at hand. However, most colleges or universities have easy access to a wealth of statistical information which can be used to determine a long range history for each of the variables. Other uses might include assessing the impact upon enrollment patterns of mandated educational policies such as P.L. 94-142 (mainstreaming) or state required changes in teacher education programs.

In summary, multiple linear regression analysis provides a much better method of predicting college enrollment than the informed "guestimate" method that had been previously employed.

References

Nie, N., Hull, C., Jenkins, J., Steinbrenner, K., and Bent, D. Statistical package for the social sciences (2nd ed.). New York: McGraw-Hill, 1975.

Table 1

Multiple Regression Analysis for Total College Enrollment with ELED Course Enrollment

Course	Multiple R	Multiple R^2	Degrees of Freedom	F
31122	.942	.888	1,4	31.758**
31123	.890	.792	1,4	15.272*
31124	.962	.926	1,4	50.099**
31125	.996	.992	1,4	512.455**
41114	.924	.855	1,4	23.517*
41122	.984	.969	1,4	123.828**
41125	.976	.953	1,4	80.939**
41131	.980	.961	1,4	97.567**
41137	.994	.987	1,4	310.421**
41138	.990	.980	1,4	198.895**

* p .05

** p .01

Table 2

Correlation Matrix of Total College Enrollment with Five Variables

Course	Course Enrollment	ELED Major	ELED +SVC	ELED FRESH	Total Univ
31122	.94	.91	.80	− .70	.23
31123	.89	.91	.87	− .70	.35
31124	.96	.91	.87	− .69	− .41
31125	.99	.91	.87	− .70	.23
41114	.92	.86	.81	− .76	.23
41122	.98	.86	.81	− .76	− .32
41125	.98	.86	.81	− .72	.23
41127	.98	.86	.81	− .76	.23
41131	.98	.86	.81	− .76	.23
41137	.99	.86	.79	− .76	.23
41138	.99	.86	.81	− .76	.23

Figure 1

Correlations and Regression Equations

For Course Enrollments

Course	Correlation	Equation
31122	.942	PE = .072(TC) + 29.018
31123	.890	PE = .052(TC) + 40.492
31124	.962	PE = .143(TC) - 151.660
31125	.996	PE = .135(TC) + 10.349
41114	.924	PE = .136(TC) + 43.606
41122	.984	PE = .159(TC) - 246.483
41125	.976	PE = .196(TC) - 168.551
41131	.980	PE = .145(TC) - 103.324
41137	.994	PE = .195(TC) - 236.180
41138	.990	PE = .114(TC) - 25.380

PE = Predicted Enrollment
TC = Total College Enrollment

Figure 2

Estimated Quarter Enrollment Based On

Percentage of Predicted Course Enrollment

	Summer 1978	Fall 1978	Winter 1979	Spring 1979	Predicted Yearly Enrollment
% of Yearly Total	07	38	30	25	66
Course Enrollment	4	25	20	17	